A STUDY OF EVALUATIONS AND RECOVERY EFFORTS IN ECOLOGY

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ABSTRACT
Plants that produce organic matters through photosynthesis are the main constituent factors of an ecosystem, and Ministry of the Environment Government of Japan has been officially announcing the degree of human disturbance of vegetation that evaluates the stability of vegetable growth. However the method is a qualitative evaluation technology. Therefore, we proposed the new quantitative method of evaluating the ecological recovery situations with the vegetation quality and quantity. Besides, we considered biodiversity and developed the ecological restoration system that can efficiently restore the local plants which can be grown stably in the area.

KEY WORDS
ecosystem, vegetation, biodiversity, ecological recovery, succession, regional plants

1. INTRODUCTION

There are two main purposes for road landscaping. One of them is preservation of living environment highway customers and roadside residents. The other is the contribution to preservation of natural environment. Various landscaping effects are used for these purposes. Some of them are well understood in their effects, while others are not. Especially, it is necessary to establish the ecosystem conservation methods based on scientific knowledge background. [1]
Landscaping, one of the ecosystem conservation methods, was required to verify its quantitative effect. The ecosystem is composed of plants (producer), animals (consumer), and microbes (decomposer), and only plants can convert solar energy into chemicals that is consumed in the ecosystem (fig.-1).
In this paper, the ecosystem restoration system including the ecosystem restoration technology is described. Research of the new method to evaluate the level of the ecosystem restoration is also discussed.

2. RESULT AND CONSIDERATION ABOUT ECOSYSTEM EVALUATION METHOD

So far, methodology to clearly evaluate the level of the ecosystem restoration has not been established. Therefore, slopes sprayed with seeds and soil work and restored its ecosystem by the naturally invaded plants was defined as a standard ecosystem restoration type for roadside plants. It is supposed that the ecosystem was restored with the progress of the succession (fig.- 2).

2.1 A conventional method

（1） Degree of Human Disturbance of Vegetation (DHDV)

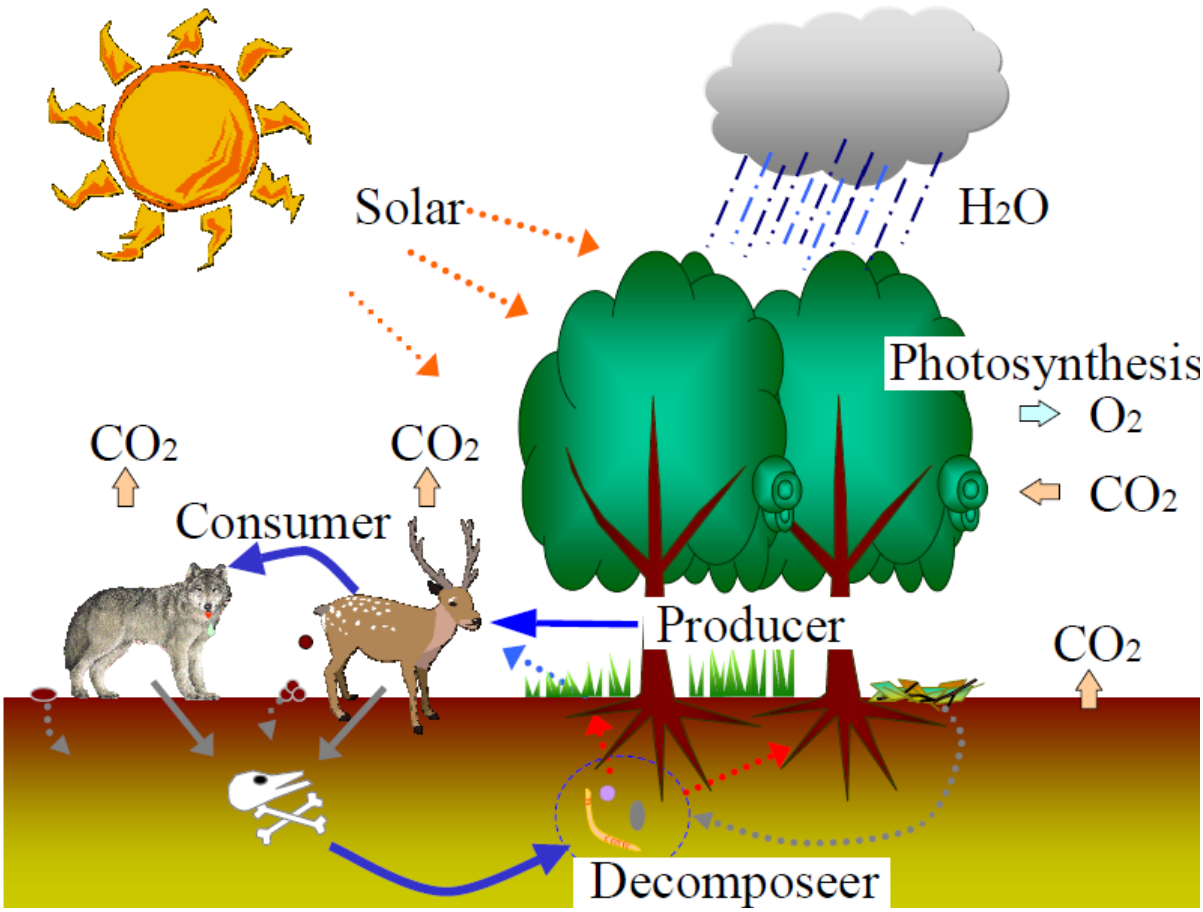


Figure -1 A conception diagram of an ecosystem

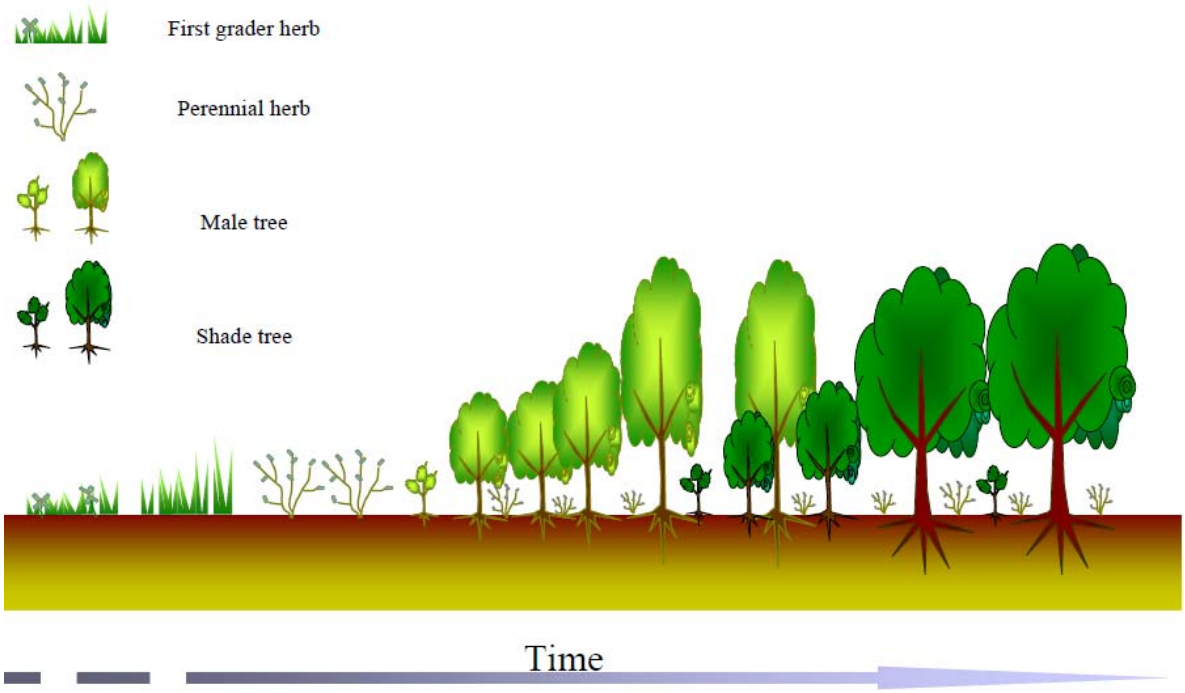


Figure –2 Vegetation succession and ecosystem reconstruction.

DHDV is one of the ecosystem evaluation methods by Ministry of the Environment (1976). [2]
It is a method to evaluate degree of the natural vegetation change by the human direct influence with a vegetation community type (Table- 1). [3]
This method has ten succession levels from DHDV-1, "urban land, developed tracts, and other zones where plant life is virtually nonexistent", to DHDV-10, "single layer natural vegetation like alpine heathland, wind-exposed grassland, natural grassland".
However, for slopes with 40 yearsin service, its degree varies only 4 levels from DHDV-4 to DHDV-7 categorized by this method. It is clear that the ecosystem reorganization speed has been increased in the planted slopes with various invaded plants during the long-term exposure. However, its slope is under-evaluated and categorized as DHDV-6. That means, The conventional evaluation method does not suitable to evaluate planted slopes in early stage of ecosystem reconstruction. The DHDV method of Ministry of the Environment evaluates the natural levels in long-term basis for several hundred years. This method is not suitable for only 40-year elapsed roadside slopes. In addition, DHDV-6 evaluates the distribution of mainly plantation with the Japanese cedar and cypress. This method is not suitable for evaluation of the slopes planted with various kinds of broadleaf trees for the ecosystem and landscape reconstructions.

（2） Degree of succession [2][4]

The species and the life-form spectrums in the vegetation community are changed as the succession progresses, and the biomass and the biodiversity of the vegetation community increase. With this life-form spectrums, Numata developed a method called DS(Degree of Succession) that can quantitavely evaluate the degree of vegetation succession in 1961.[5] This is based on the fact that the long existence species increase as the succession progresses.
DS is calculated by equation(1). The dominance is an index that shows the state of ecological superiority in the vegetation community. Dominance can be calculated by several types of equations.

$$DS = \frac{v}{n}\sum dL \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots(1)$$

where: L = longevity of the species, d = dominance, n = number of species", and v = percentage of vegetation coverage

This "$\frac{1}{n}\sum dL$ " shows the average period of existence for species in a community. Degree of succession is not obtained by multiplying this value by the percentage of vegetation coverage. It is difficult to compare various DS values calculated by different equations of dominance.

2.2 A new ecosystem evaluation method(A New Degree of Succession)[2][4]

The recovery of ecosystem tends to accelerate as the advancement of succession. That tendency can be used for estimation of sufficient ability to evaluate the ecosystem reconstruction levels.
Furthermore, we have developed the following equation (DS'; new degree of succession) that is not controlled by dominance calculation methods with average existence "$DS = \frac{\sum dL}{\sum d}v$" respected the dominance.

$$DS = \frac{\sum dL}{\sum d}v \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots(2)$$

The maximum value of DS' in the above equation is 100, and the results can be compared with each other. Figure-3 shows the correlation between elapsed years and DS or DS' with data in Table -2. The coefficient of correlation by equation (2) (r =0.8982) is greater than in equation(1) (r =0.8706). In addition, the correlations were found between DS' and microbe activity (Figure-4), all carbon (Figure-5), the number of flesh-eating insects(Figure-6) or the number of soil animals(Figure-7). The ecosystem consists of a producer, a consumer and a decomposer. Equilateral correlations were recognized between DS' and the ecosystem by a flesh-eating insect (a consumer) located in the high rank of the ecosystem and for the connections between a plant (a producer) and a soil animal (a decomposer). It is revealed from these results that it is possible to evaluate the degree of ecosystem change using DS'

value (Table-3).

3. INTEGRATED PLANTING METHOD WITH REGIONAL SEEDS [6]

It is necessary to conserve the biodiversity with the gene level technology in the region, like a national park, where natural environment is protected. Ligneous plant seeds spray work method has problems in difficulty to find seeds, the low germination rate and mixed foreign wood species. Therefore, we think that biodiversity has troubles with this method. Then, the integrated planting method with regional seeds was developed in the following conditions (Photo-1).

① Many species can survive regardless of seasons in planting.
② The amount of work for changes of the slopes is minimized, and ensure safety, facility, and cost performance.
③ In biodiversity it has the traceability with the plants by using of the regional seeds.

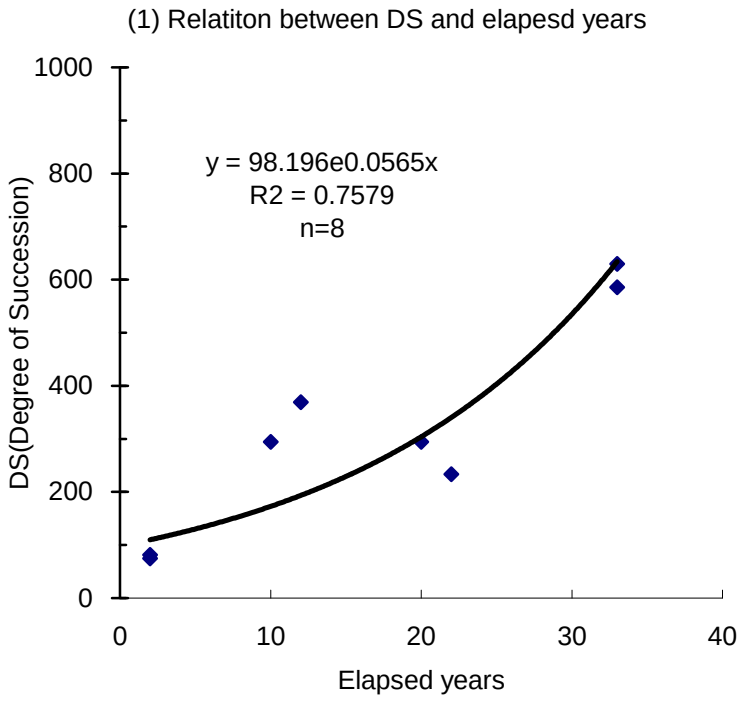
The integrated planting method is the one to integrate the regional plants, the carrying soil, the manure and the mulching, and put them on the ground directly. By applying this method, about 70% of the time would be reduced. The integrated planting method with regional seeds has the following effects.

① Carbon dioxide is fixed and contributes to the global environment conservation.
② It preserve ecosystems in ecosystem level, inter-specific level and intra-specific(gene) level.
③ It prevents a genetic disturbance in a local population level.

In other words, by passing through the following stage, an ecosystem reconstruction system is formed from an investigation to an evaluation (Figure-8).

① The species are fixed by the field works.
② Seeds are gathered and selected.
③ A selecting seed is bred up and the bred cultivar is used for a construction as a regional plant.
④ The ecosystem reconstruction degree is evaluated by DS'.

The regional plants have been produced about 500,000 since 1996 and breed plants of 400,000 with about 200 kinds now. We are going to breed various plants that are adapted to regions and added value such as traceability.



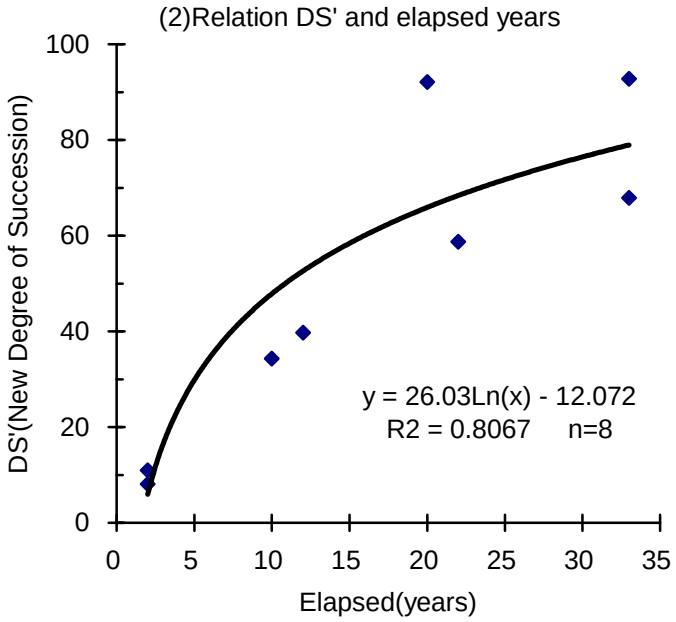


Figure -3 Comparison of two calculation methods in the degree of succession

Table ? Investigation summary

Item	Contents
Location in Highway (number of point, elapsed years)	Mei-Shin Exp.(2points, 33), Kan-Etsu Exp.(1points, 22), Chuo Exp.(1points, 20), Higashi-Kanto Exp.(2points, 10･12), Tateyama Exp.(2points, 2)
Vegetation survey	Quadrat method by phytosociology
Soil survey	SH type cone penetrometer(Soil Hardness), Boring stick(soil texture, structure, color, acidity, water, three phase, carbon),
Soil fauna	Tullgren method(macrofauna), chloroform fumigation extraction method(biomass carbon)

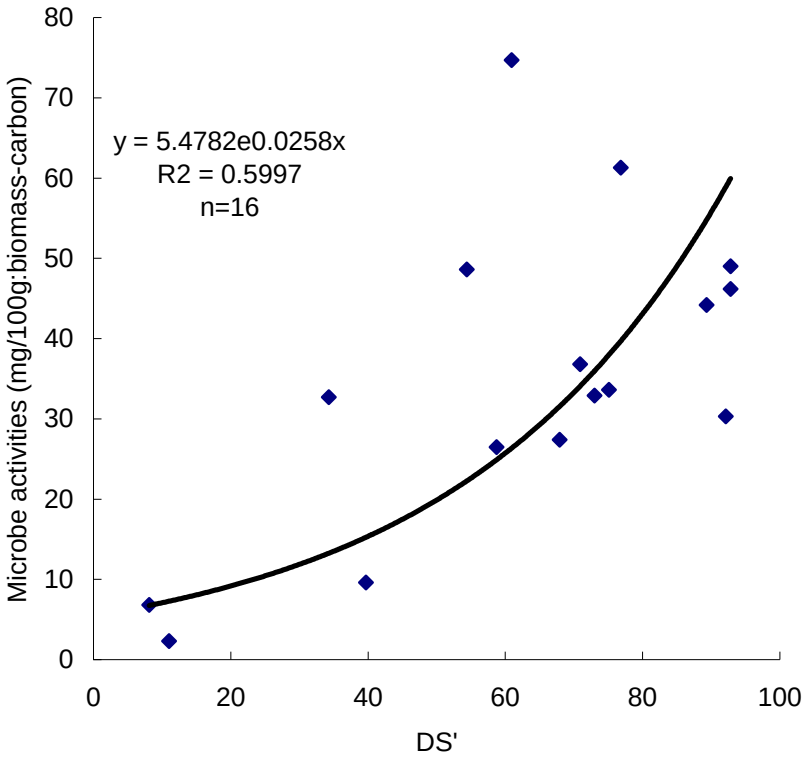


Figure-4 Correlations between DS' and Microbe activities

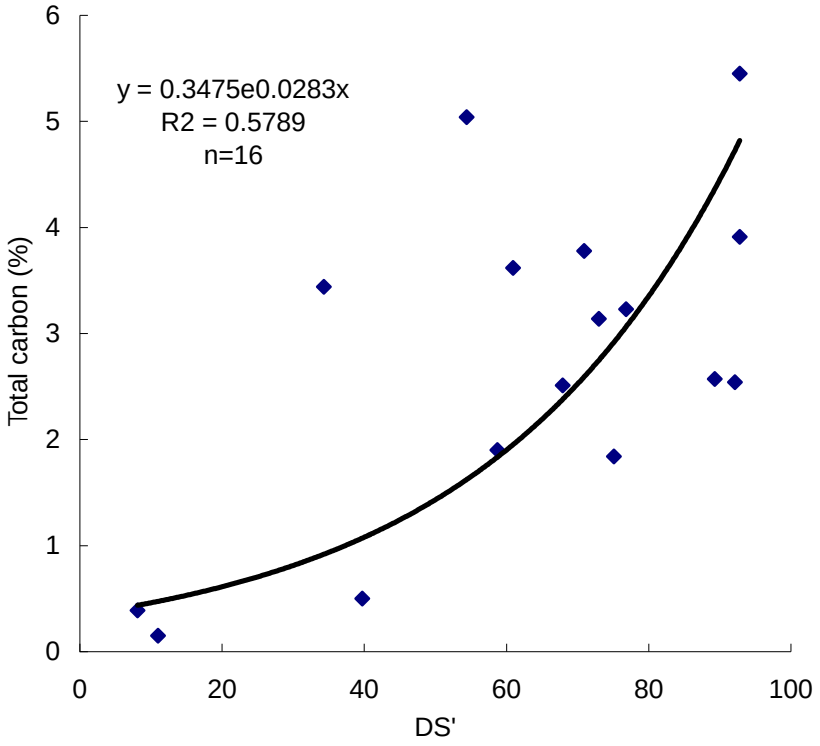


Figure-5 Correlations between DS' and Total Carbon

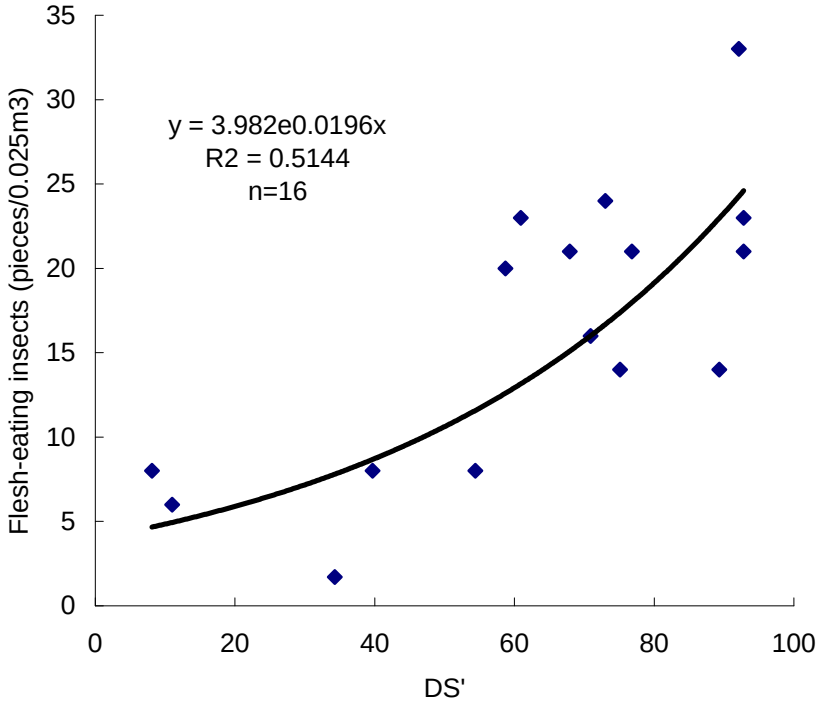


Figure-6 Correlations between DS' and Flesh-eating Insects

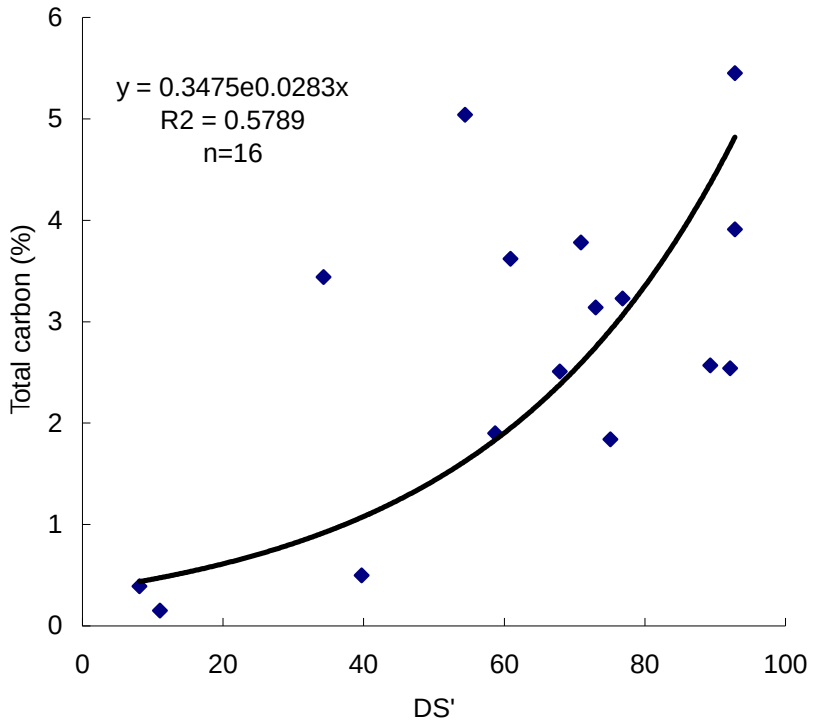


Figure-7 Correlations between DS' and Soil Animals

Table-3 Example of calculating DS and DS`

Location (Exp.Highway)	Elapsed years	DS	DS`
Mei-Shin	33	585. 7	67. 9
	33	629. 7	92. 8
Kan-Etsu	22	233. 6	58. 7
Chuo	20	294. 4	92. 1
Higashi-Kanto	10	294. 4	34. 3
	12	369. 3	39. 7
Tateyama	2	81. 4	8. 1
	2	67. 8	11. 0

Photo -1 An example of the slope with the regional plants

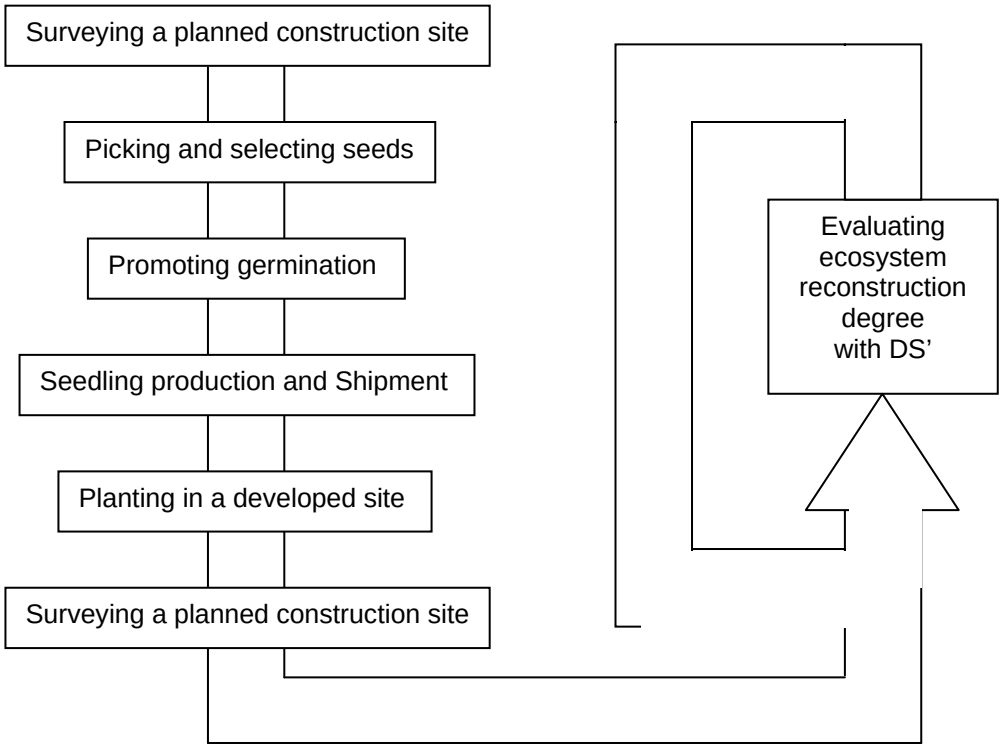


Figure-8 Overview flowchart about the integrated planting system with regional seeds

4. CONCLUSION

In this paper, a method to evaluate the ecosystem with the quantitative analysis was suggested. In the future, we will consider the evaluation technology that is integrated quantitative elements with qualitative ones by qualitative reviews. Our company has many abundant results in an ecosystem reconstruction field and ready to contribute to the society from consulting to breeding plants. We would like to contribute our business to society with our ecosystem reconstruction system, using oue advantage to take comprehensive countermeasures.

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